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Miya

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(54) **CDMA RADIO MULTIPLEX TRANSMITTING DEVICE AND A CDMA RADIO MULTIPLEX RECEIVING DEVICE**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

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(51) **Int. Cl.**[7] **H04B 7/216**
(52) **U.S. Cl.** **370/335**; 370/328; 370/441
(58) **Field of Search** 370/335, 342, 370/320, 441, 479, 500, 350, 468, 280; 375/200, 260, 38

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,191,576	*	3/1993	Pommier	375/260
5,420,850	*	5/1995	Umeda	370/18
5,519,730	*	5/1996	Jasper	375/260
5,559,789	*	9/1996	Nakano	370/18
5,673,260	*	9/1997	Umeda	370/242
5,920,817	*	7/1999	Umeda	455/437
6,097,711	*	8/2000	Okawa	370/335

FOREIGN PATENT DOCUMENTS

5276132 10/1993 (JP) .

OTHER PUBLICATIONS

IEEE 47th, Vehicular Technology Conference Proceedings, Technology in Motion, vol. 2, entitled "CDMA/TDD Cellular Systems for the 3rd Generation Mobile Communication", May 4-7, 1997 by Miya et al.

"Performance of Coherant RAKE Detection Using Interpolation on DS/CDMA" by Higashi et al., at pp. 57–62 of *The Institute of Electronics Information And Communication Engineers (IEICE), (IEICE) Technical Report of IEICE*, A–P94–74, RCS94–98 (1994–10), along with an English Language Abstract.

A Japanese Language abstract of JP5–276132.

Seiichii SAMPEI, "Rayleigh Fading Compensation Method for 16QAM MODEM in Digital Land Mobile Radio Systems", at pp. 7–15 of *IEICE* B–II (1989).

* cited by examiner

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(57) **ABSTRACT**

In the CDMA Radio Multiplex Transmission, transfer function of line is inferred by using common pilot signal and synchronous detection is performed accordingly. The transmitting end transmits by periodically inserting pilot symbols into one channel only of multiplexed channels. The receiving end infers line condition (transfer function) from the received pilot symbols and, on the basis of the information thus obtained, performs synchronous detection of each channel multiplexed.

40 Claims, 14 Drawing Sheets

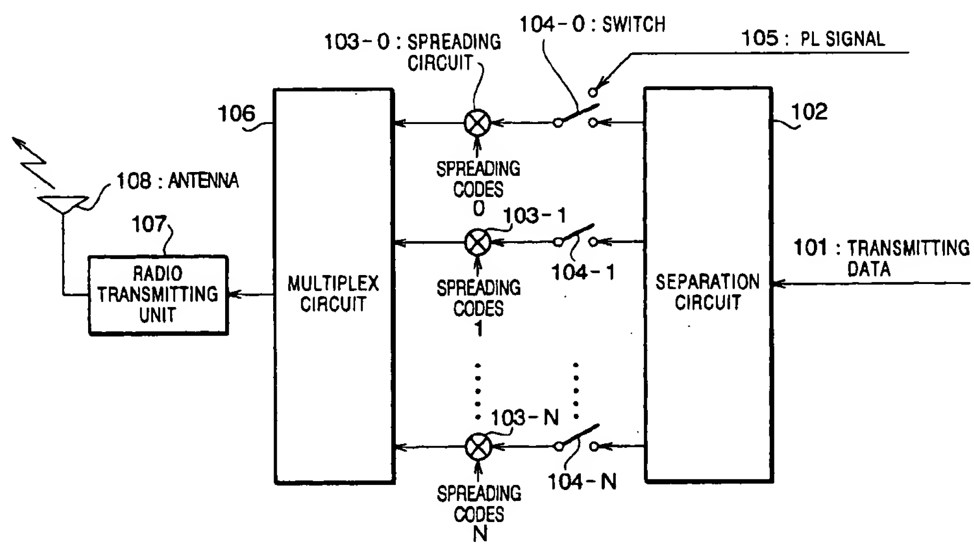
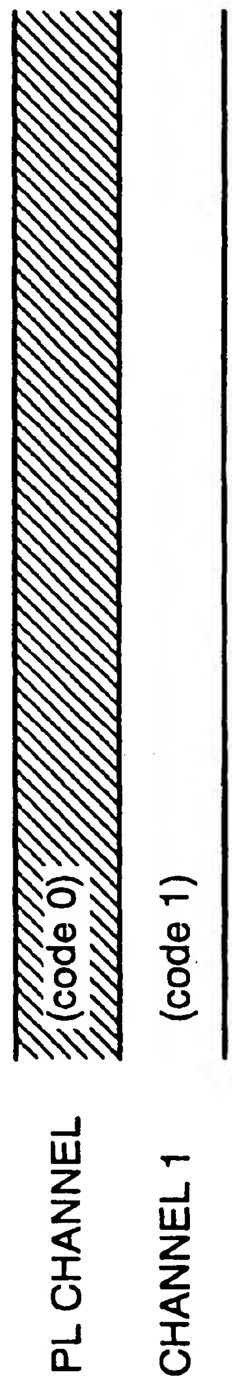


FIG. 1



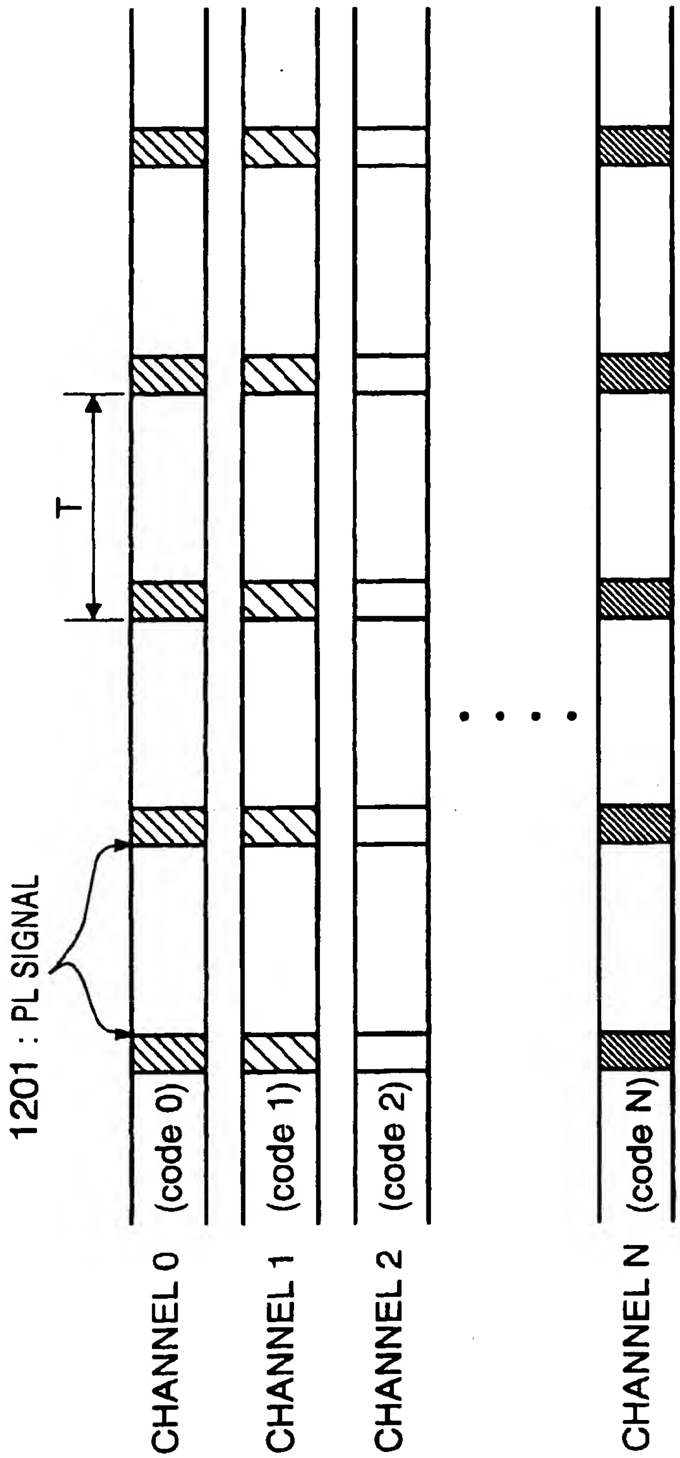

1201 : PL SIGNAL
T
CHANNEL 0
(code 0)
CHANNEL 1
(code 1)
CHANNEL 2
(code 2)
CHANNEL N
(code N)

FIG. 2

FIG. 3

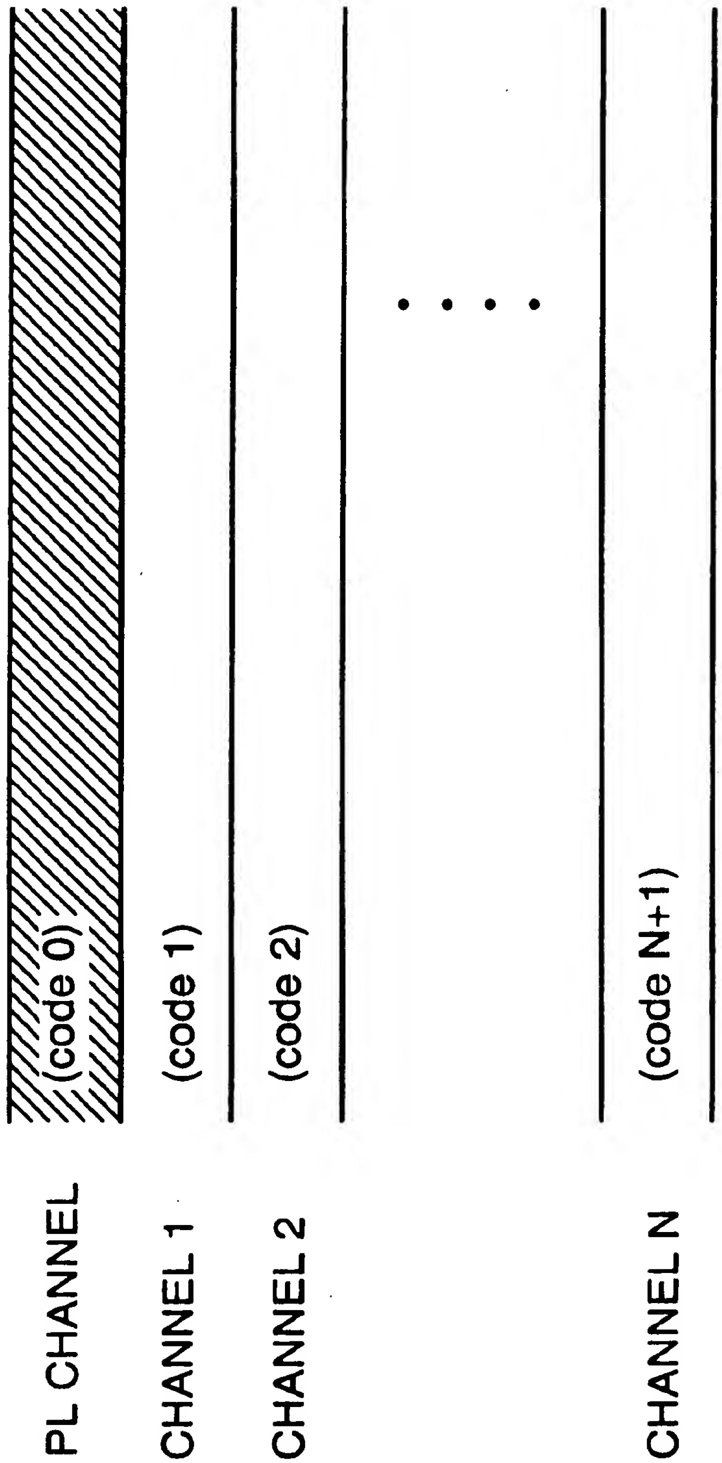
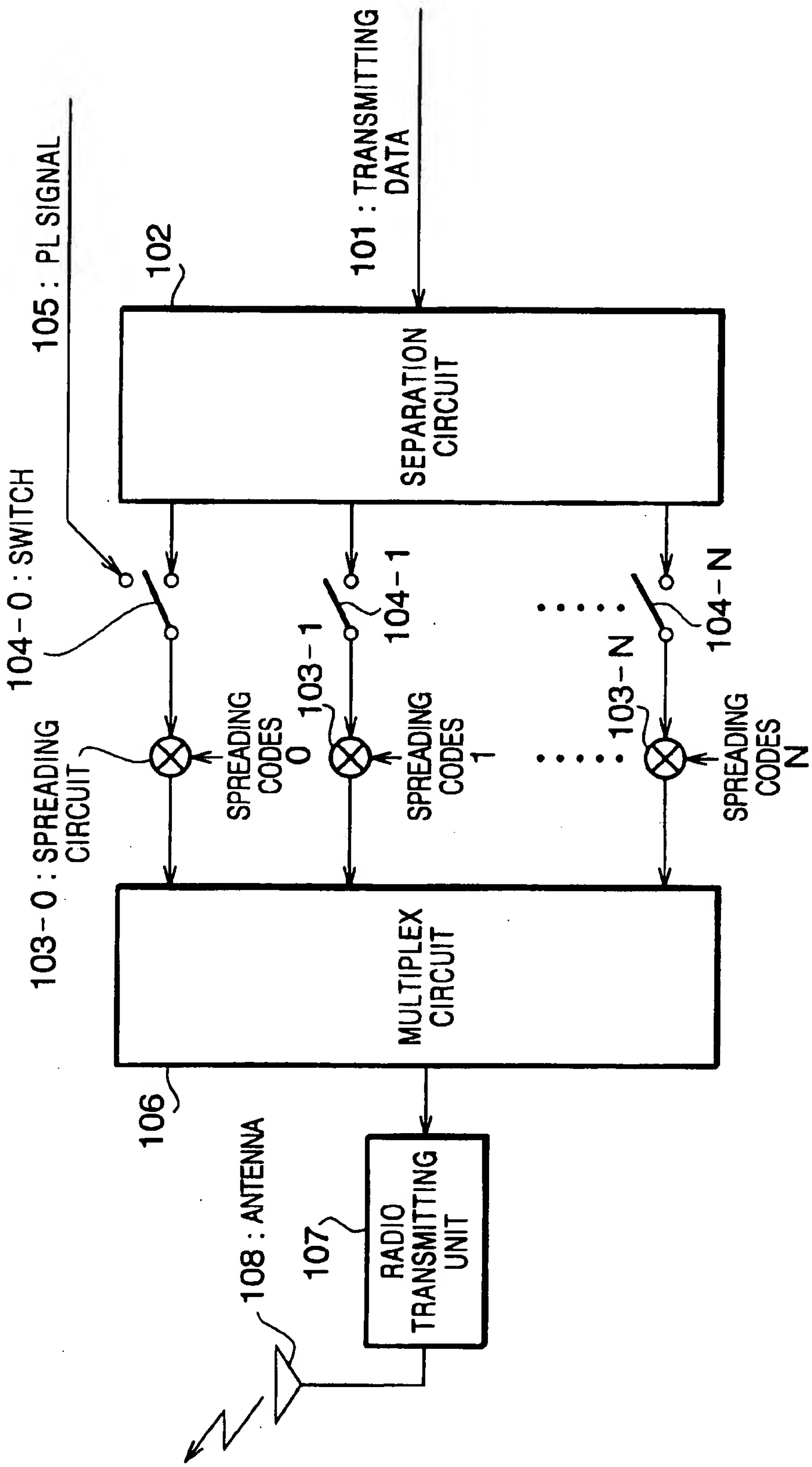

PL CHANNEL
(code 0)
CHANNEL 1
(code 1)
CHANNEL 2
(code 2)
CHANNEL N
(code N+1)

FIG. 4


101 : TRANSMITTING DATA
105 : PL SIGNAL
102
SEPARATION CIRCUIT
104-0 : SWITCH
104-1
104-N
103-0 : SPREADING CIRCUIT
103-1
103-N
SPREADING CODES 0
SPREADING CODES 1
SPREADING CODES N
MULTIPLEX CIRCUIT
106
107
RADIO TRANSMITTING UNIT
108 : ANTENNA

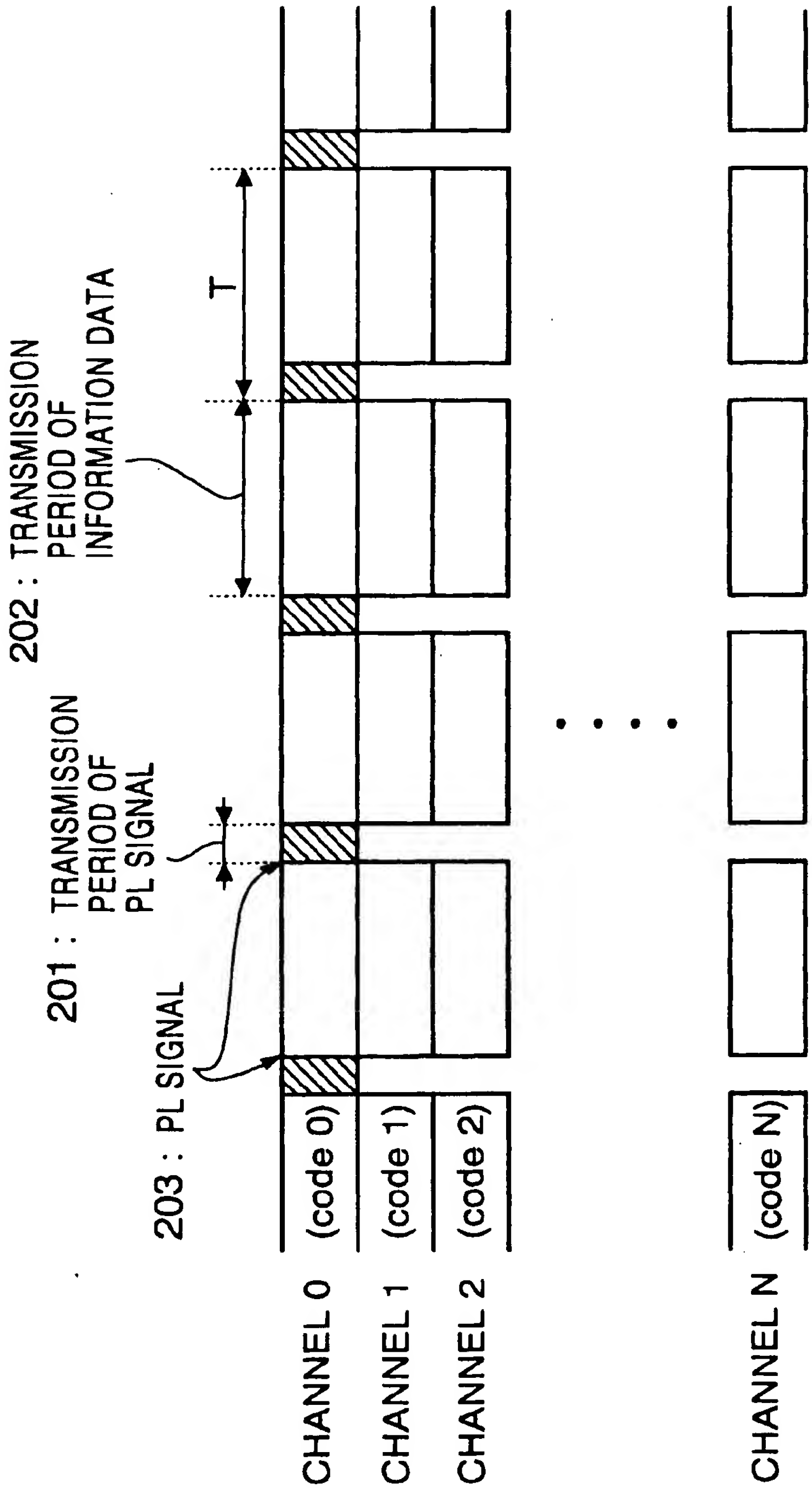

202 : TRANSMISSION PERIOD OF INFORMATION DATA
T
201 : TRANSMISSION PERIOD OF PL SIGNAL
203 : PL SIGNAL
CHANNEL 0 (code 0)
CHANNEL 1 (code 1)
CHANNEL 2 (code 2)
CHANNEL N (code N)

FIG. 5

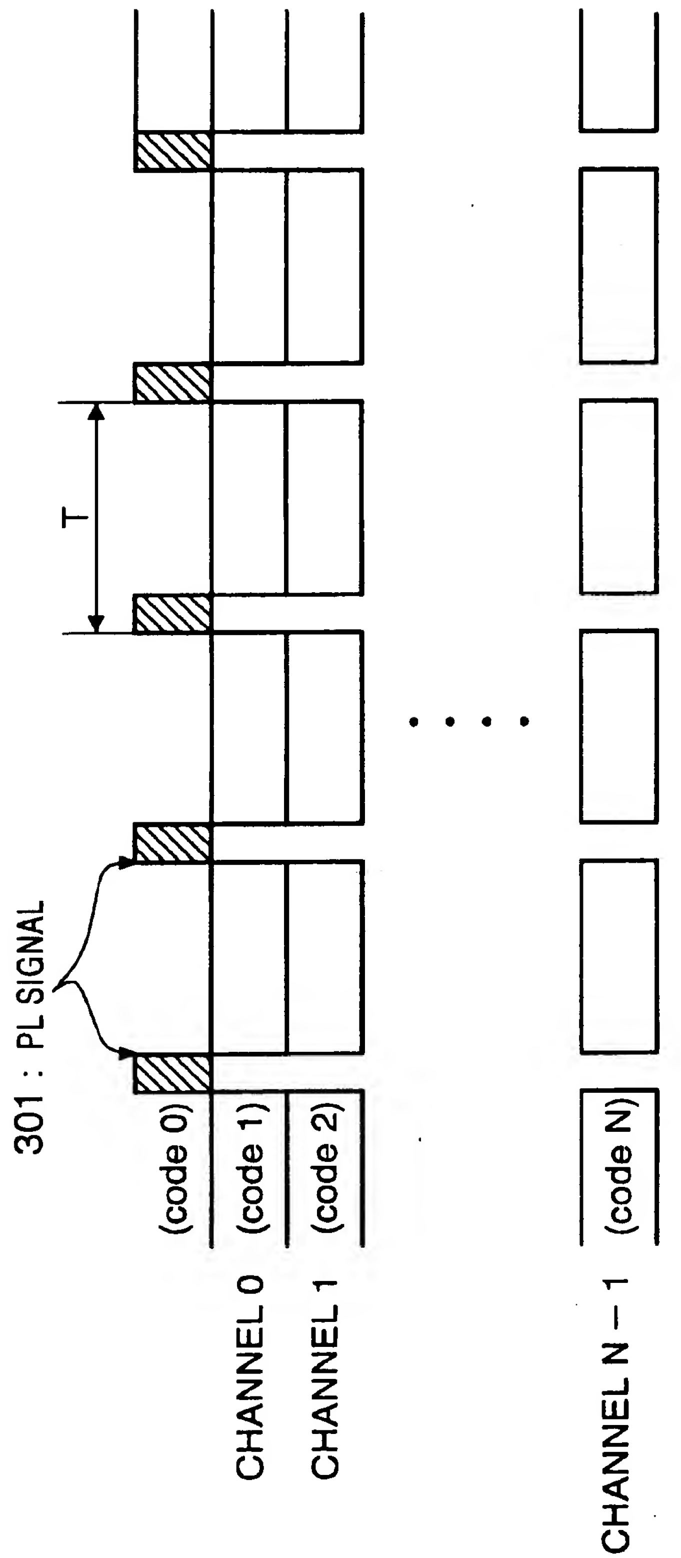

301 : PL SIGNAL
T
(code 0)
(code 1)
(code 2)
(code N)
CHANNEL 0
CHANNEL 1
CHANNEL N – 1

FIG. 6

FIG. 7

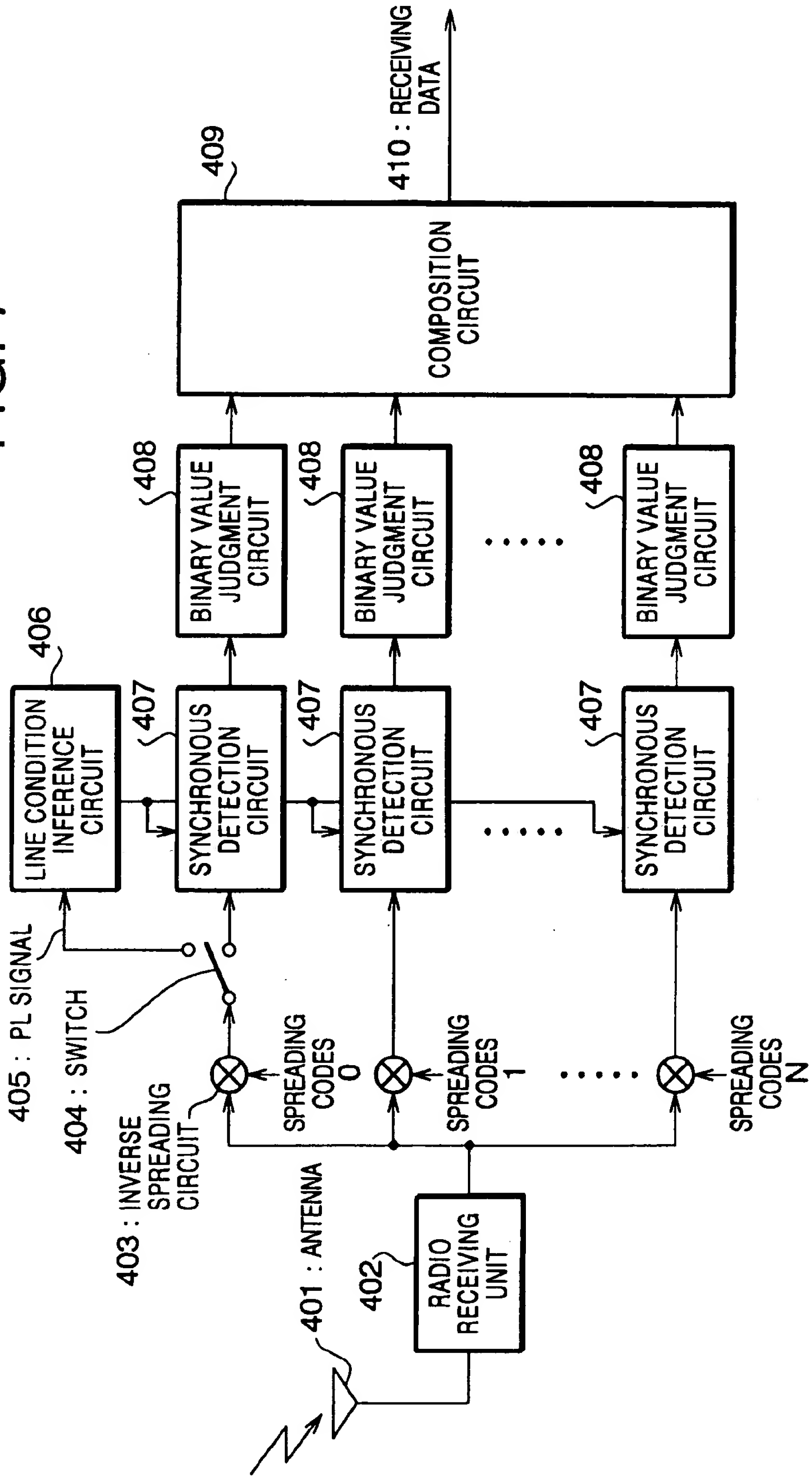
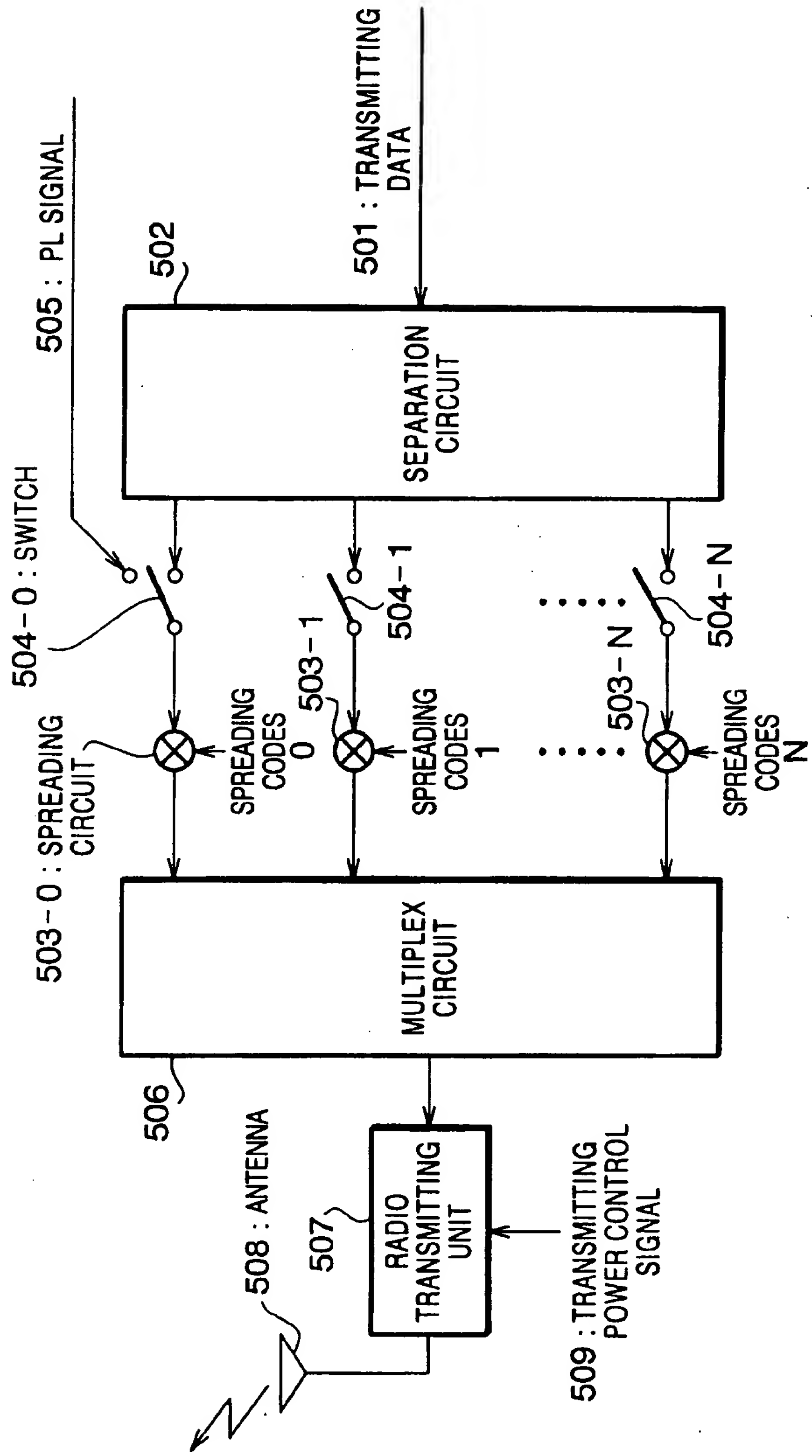

410 : RECEIVING DATA
409
COMPOSITION CIRCUIT
408
BINARY VALUE JUDGMENT CIRCUIT
408
BINARY VALUE JUDGMENT CIRCUIT
408
BINARY VALUE JUDGMENT CIRCUIT
406
LINE CONDITION INFERENCE CIRCUIT
407
SYNCHRONOUS DETECTION CIRCUIT
407
SYNCHRONOUS DETECTION CIRCUIT
407
SYNCHRONOUS DETECTION CIRCUIT
405 : PL SIGNAL
404 : SWITCH
403 : INVERSE SPREADING CIRCUIT
SPREADING CODES 0
SPREADING CODES 1
SPREADING CODES N
401 : ANTENNA
402
RADIO RECEIVING UNIT

FIG. 8


501 : TRANSMITTING DATA
502
SEPARATION CIRCUIT
505 : PL SIGNAL
504-0 : SWITCH
504-1
504-N
503-0 : SPREADING CIRCUIT
503-1
503-N
SPREADING CODES 0
SPREADING CODES 1
SPREADING CODES N
MULTIPLEX CIRCUIT
506
507
RADIO TRANSMITTING UNIT
508 : ANTENNA
509 : TRANSMITTING POWER CONTROL SIGNAL

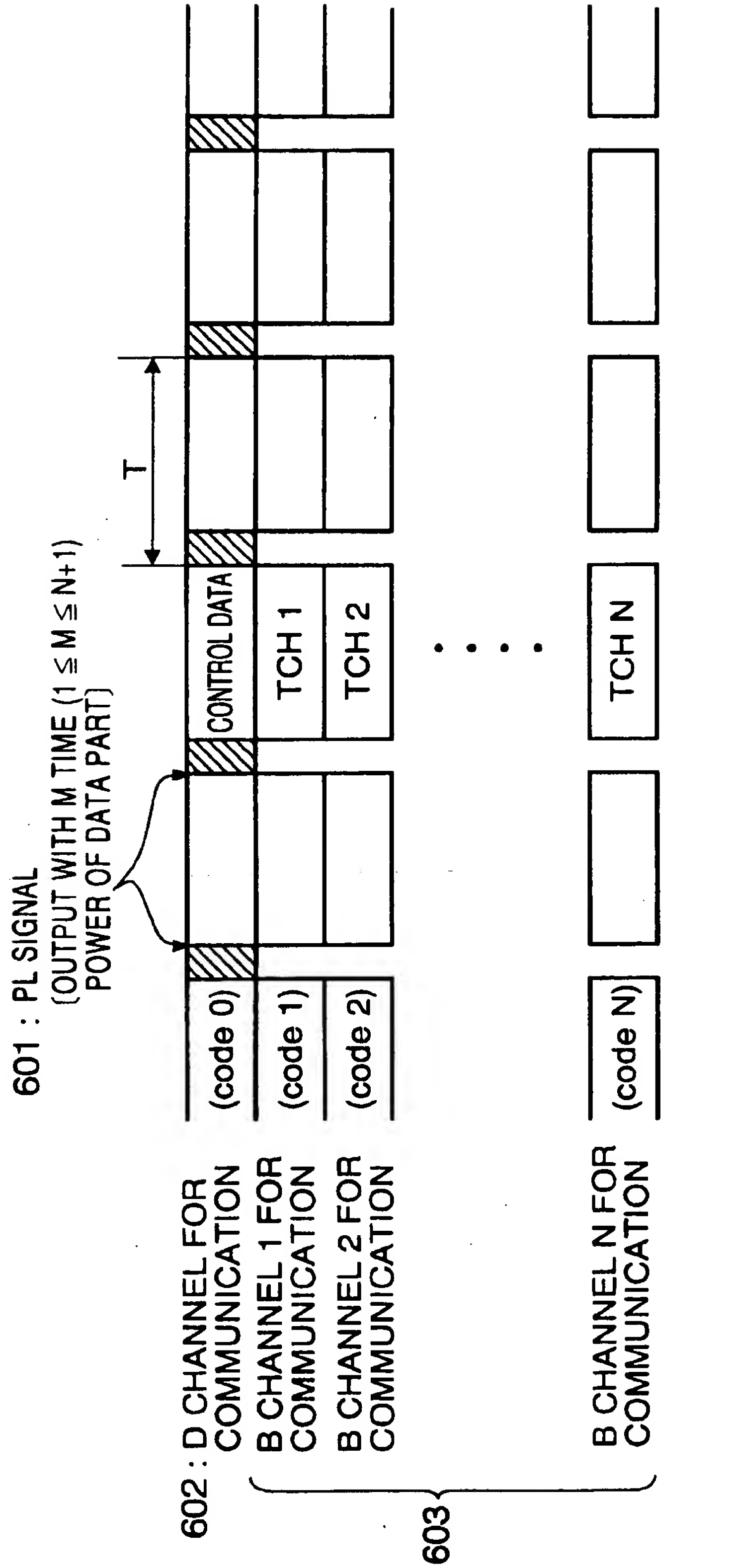

601 : PL SIGNAL
(OUTPUT WITH M TIME (1 ≤ M ≤ N+1)
POWER OF DATA PART)
T
602 : D CHANNEL FOR COMMUNICATION
(code 0)
CONTROL DATA
B CHANNEL 1 FOR COMMUNICATION
(code 1)
TCH 1
B CHANNEL 2 FOR COMMUNICATION
(code 2)
TCH 2
B CHANNEL N FOR COMMUNICATION
(code N)
TCH N
603

FIG. 9

FIG. 10

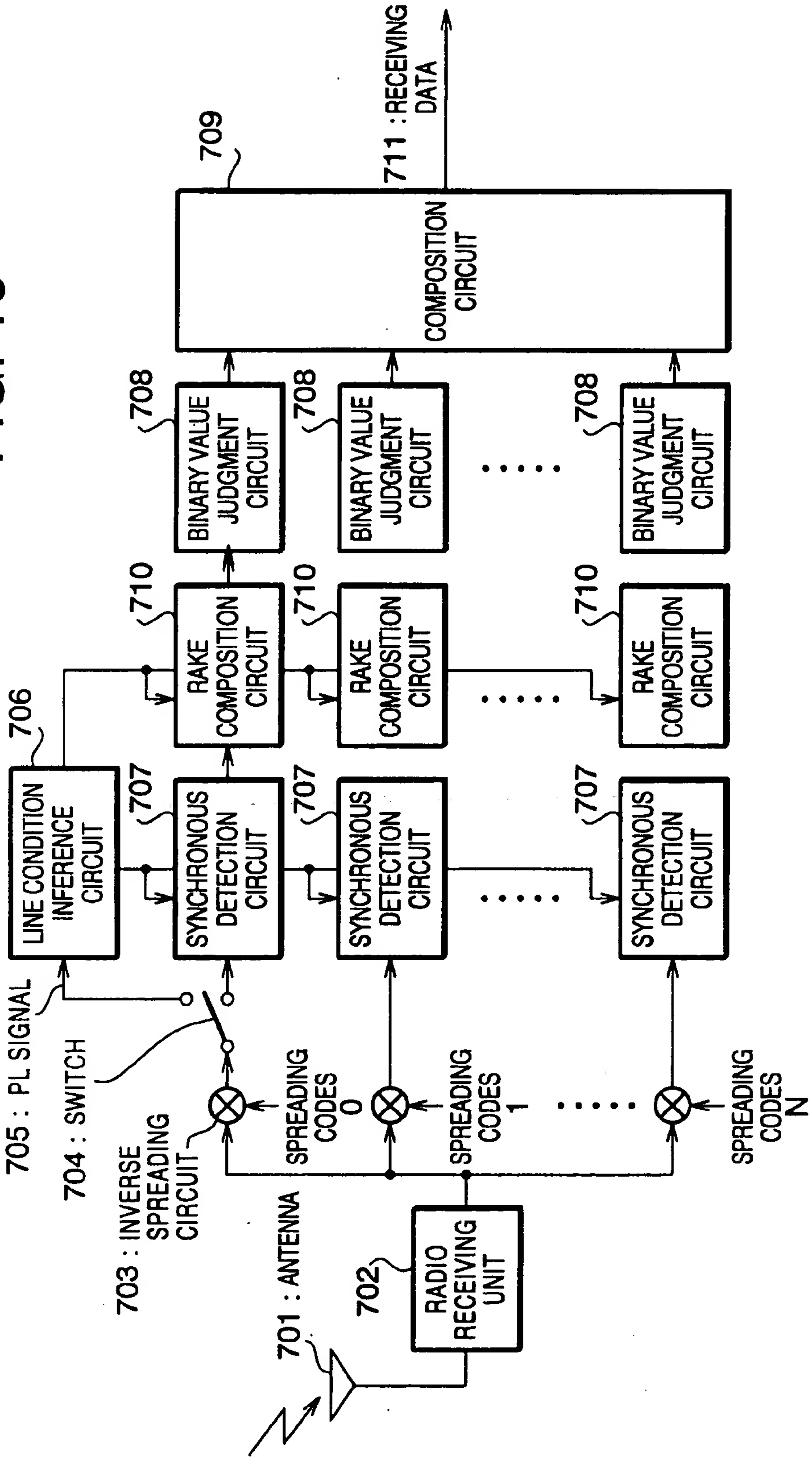

701 : ANTENNA
702
RADIO RECEIVING UNIT
703 : INVERSE SPREADING CIRCUIT
SPREADING CODES 0
SPREADING CODES 1
SPREADING CODES N
704 : SWITCH
705 : PL SIGNAL
706
LINE CONDITION INFERENCE CIRCUIT
707
SYNCHRONOUS DETECTION CIRCUIT
710
RAKE COMPOSITION CIRCUIT
708
BINARY VALUE JUDGMENT CIRCUIT
709
COMPOSITION CIRCUIT
711 : RECEIVING DATA

FIG. 11

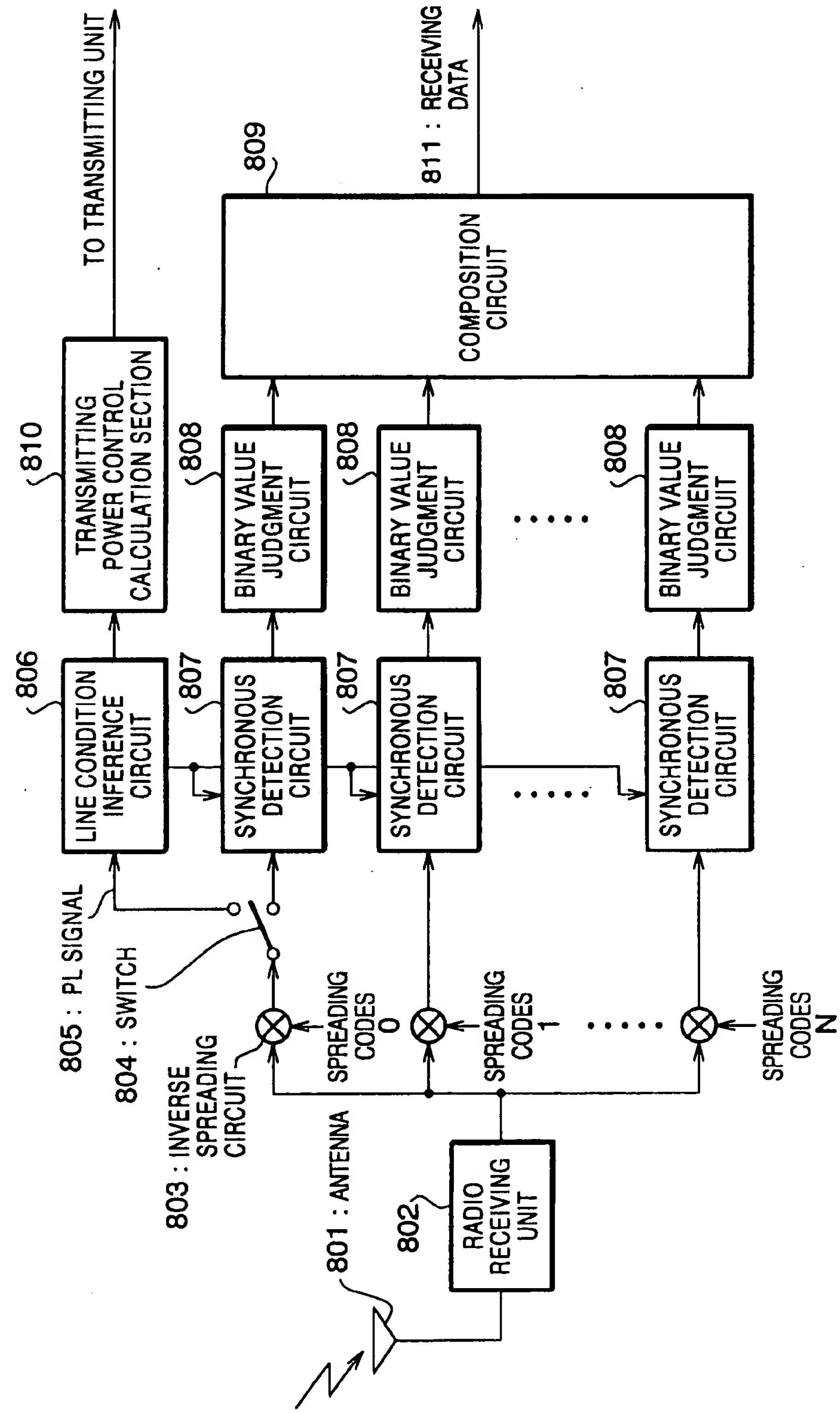
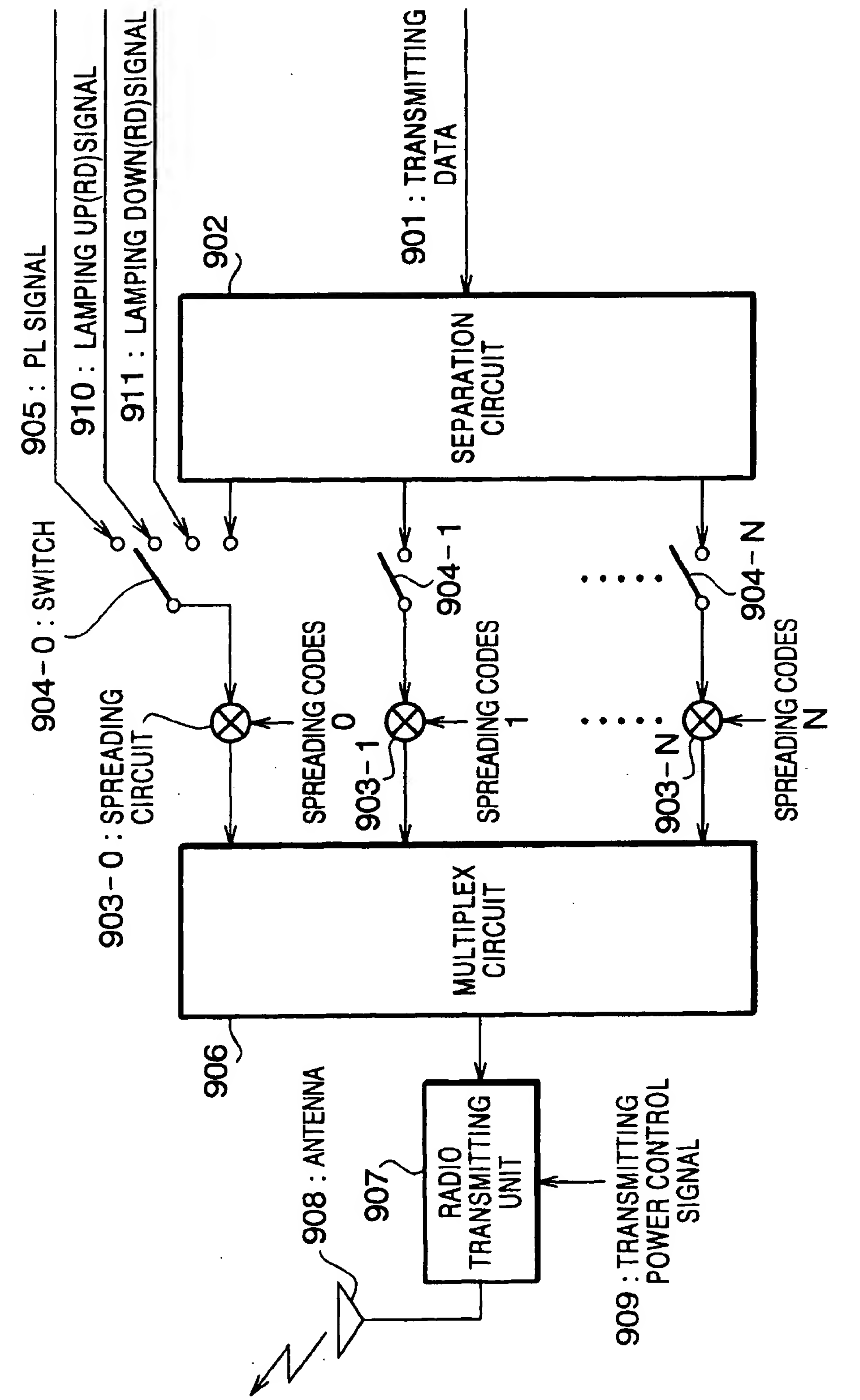

TO TRANSMITTING UNIT
811 : RECEIVING DATA
809
COMPOSITION CIRCUIT
810
TRANSMITTING POWER CONTROL CALCULATION SECTION
808
BINARY VALUE JUDGMENT CIRCUIT
808
BINARY VALUE JUDGMENT CIRCUIT
808
BINARY VALUE JUDGMENT CIRCUIT
806
LINE CONDITION INFERENCE CIRCUIT
807
SYNCHRONOUS DETECTION CIRCUIT
807
SYNCHRONOUS DETECTION CIRCUIT
807
SYNCHRONOUS DETECTION CIRCUIT
805 : PL SIGNAL
804 : SWITCH
SPREADING CODES 0
SPREADING CODES 1
SPREADING CODES N
803 : INVERSE SPREADING CIRCUIT
801 : ANTENNA
802
RADIO RECEIVING UNIT

FIG. 12


905 : PL SIGNAL
910 : LAMPING UP(RD)SIGNAL
911 : LAMPING DOWN(RD)SIGNAL
901 : TRANSMITTING DATA
902
SEPARATION CIRCUIT
904-0 : SWITCH
904-1
904-N
903-0 : SPREADING CIRCUIT
SPREADING CODES 0
903-1
SPREADING CODES 1
903-N
SPREADING CODES N
MULTIPLEX CIRCUIT
906
908 : ANTENNA
907
RADIO TRANSMITTING UNIT
909 : TRANSMITTING POWER CONTROL SIGNAL

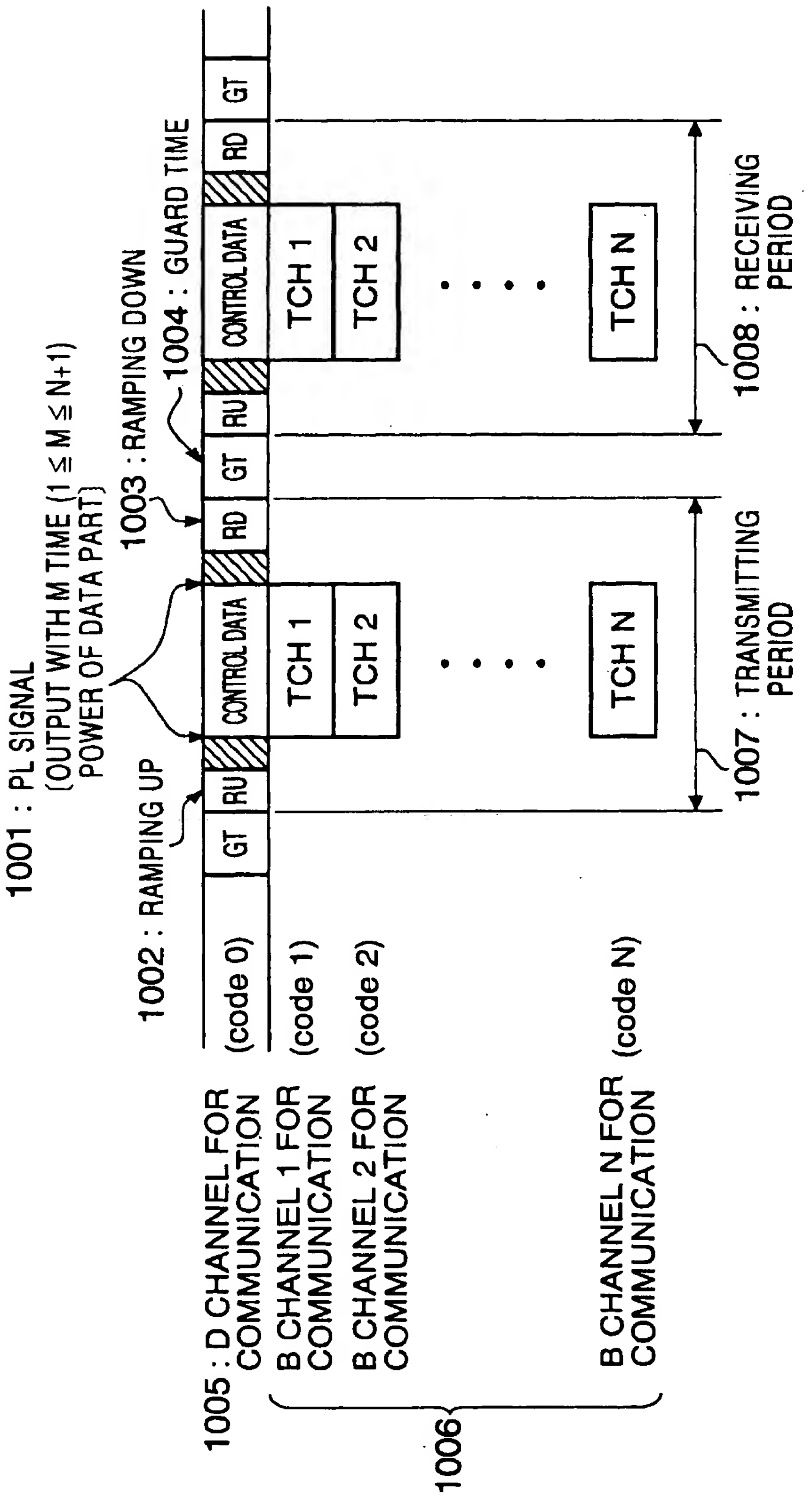

1001 : PL SIGNAL
(OUTPUT WITH M TIME (1 ≦ M ≦ N+1)
POWER OF DATA PART)
1002 : RAMPING UP
1003 : RAMPING DOWN
1004 : GUARD TIME
GT
RU
CONTROL DATA
RD
GT
RU
CONTROL DATA
RD
GT
TCH 1
TCH 2
TCH N
TCH 1
TCH 2
TCH N
1007 : TRANSMITTING PERIOD
1008 : RECEIVING PERIOD
(code 0)
(code 1)
(code 2)
(code N)
1005 : D CHANNEL FOR COMMUNICATION
B CHANNEL 1 FOR COMMUNICATION
B CHANNEL 2 FOR COMMUNICATION
B CHANNEL N FOR COMMUNICATION
1006

FIG. 13

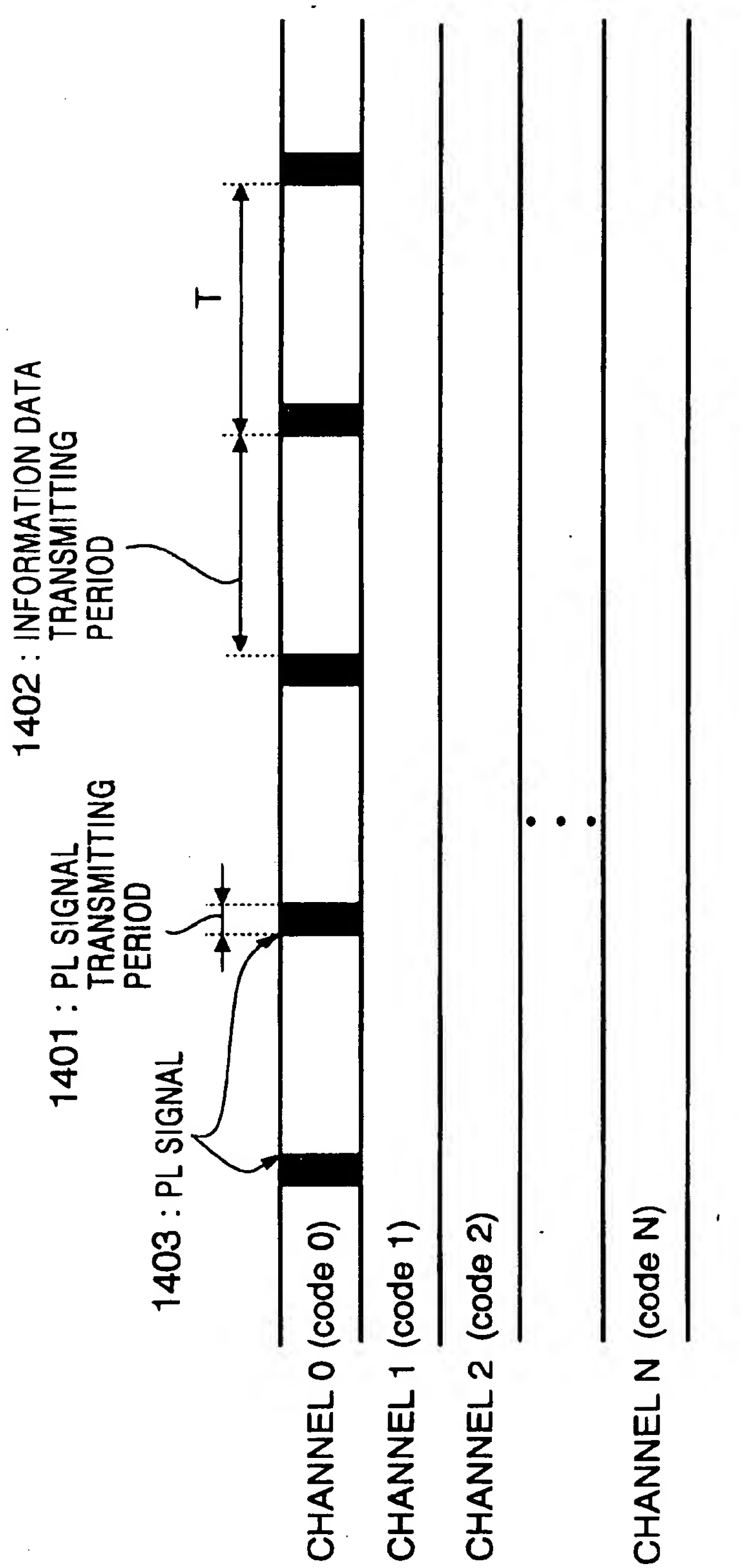

1402 : INFORMATION DATA TRANSMITTING PERIOD
T
1401 : PL SIGNAL TRANSMITTING PERIOD
1403 : PL SIGNAL
CHANNEL 0 (code 0)
CHANNEL 1 (code 1)
CHANNEL 2 (code 2)
CHANNEL N (code N)

FIG. 14

CDMA RADIO MULTIPLEX TRANSMITTING DEVICE AND A CDMA RADIO MULTIPLEX RECEIVING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the CDMA radio multiplex transmitting device and the CDMA radio multiplex receiving device used for digital cellular communication or the like.

2. Description of the Related Art

A multiple access system is a line access system for plural stations to communicate in the same band at the same time, and one of the multiple access systems is a CDMA (Code Division Multiple Access) system. The CDMA system is a technology for multiple-accessing by spread spectrum spreading communication transmitting spectrum of an information signal spread into a fairly wide band width comparing to the original information band width. This is also called as Spread Spectrum Multiple Access (SSMA). A system multiplying a spreading sequence code as it is, by an information signal for the purpose of spread spectrum spreading is called as a direct spreading CDMA system. In the direct spreading CDMA system, it is required to make strength of both an interference wave (communication wave from other station) and a desired wave identical at a receiving end in order that plural communications can jointly have the same frequency band. This is generally called as near and far problems. Solution of this far to near problem is a prerequisite for realization of a CDMA transmission system.

The near and far problems noticeably arise for the reception in a base station which receives radio waves from many stations (mobile stations, etc.) in different locations at the same time. Hence arises a necessity for mobile stations to execute a transmitter power control according to the condition of each transmission line.

Further, in radio communication system, a TDD (Time Division Duplex) system is known which tries to improve frequency utilization efficiency by using the same frequency band for both transmitting and receiving ends. The TDD system is also called as a ping-poing system which is a system for communicating by time-sharing the same radio frequency for both transmission and reception.

Still further, among detection systems in digital communication, a synchronous detection system has an excellent static characteristics compared to a delay detection system and it is a system where Eb/10 necessary for obtaining a certain average bit error rate (BER) is the lowest. As a system for compensating distortion of transmitting signals by fading, an insertion type synchronizing system is proposed ("a system for compensating phasing distortion of 16QAM for land mobile communication" by Mr. Seiichi Mihei, transactions of IEICE, B-11 Vol. J72-B-11 No. 1 pp. 7–15, 1989). In this system, a pilot symbols is periodically inserted into an information symbol to be transmitted and a detection is executed by inferring a transfer function of channel, that is to say, a line condition. Also, a system adopting the above described system to the direct spreading CDMA is proposed ("Characteristics of an insertion type synchronizing system in DS/CDMA" by Messrs. Azuma, Taguchi and Ohono, IEICE, technical report RCS94-98, 1994).

While, as a system making a synchronous detection possible in the direct spreading CDMA, there is a pilot channel. This is a system transmitting always independently

from a channel which transmits the information data by making one channel (spreading code) as a reference signal for detection. An example of channel format is shown in FIG. 1. Synchronous detection of the information data is executed on the basis of an inferred phase by inferring a phase of a channel which transmits the information data from a signal of a inversely spread pilot channel. In this case, there are instances where a pilot signal (PL signal) is transmitted in a strong electric power to improve its reliability compared to a channel transmitting other information data, etc.

In the direct spreading CDMA, there is a multi code transmission which is a system where an information exceeding an information transmitting speed per one channel (one spreading code) is transmitted. This is a system where, by allotting to one user plural channels, that is to say, a plurality of spreading codes, the transmitting end multiplexes and transmits the information data by dividing it into plural channels. In the case where a synchronous detection is performed in the multi code transmission, it is supposed that said pilot symbols or pilot channel is used.

FIG. 2 shows an example of a channel format wherein the multicode transmission is performed by using the pilot symbols. The information data is transmitted by using N+1 channels (spreading codes 0~N). A pilot symbols (pilot signal) 1201 is inserted into each channel at an interval of T period. Accordingly, it is possible that the receiving end executes a synchronous detection per each channel by using the pilot symbols.

However, in the above described conventional multi code transmission, a transmitter power of the pilot symbols is identical with the information data. Also, there is interference with the pilot symbols, particularly an effect of the interrelation among spreading codes, and for this reason it is difficult to perform a highly reliable synchronous detection.

While, FIG. 3 illustrates an example of a signal format in the case where the multi code transmission is performed by using the pilot channel. The receiving end executes a phase inference from a signal of a inversely spread pilot channel and, on the basis of the inferred phase, executes a synchronous detection of the information data in channels 1–N. However, in this case, since the PL signal is transmitted through the pilot channel in the information data transmitting period of channels 1–N, the information data signal is interfered with the PL signal. Also, the PL signal is interfered with the information data. Especially in the case where the PL signal is transmitted by an electric power higher than an information data transmitting channel so as to improve its reliability, a significant interference is caused.

SUMMARY OF THE INVENTION

The present invention is made in the light of the above described situation and its object is to provide an excellent transmitting device and its receiving device which can improve performance of a synchronous detection by improving reliability of a pilot symbols in a CDMA radio multiplex transmission.

In order to realize the above described object of the present invention, it is so arranged that the transmitting end transmits by periodically inserting the pilot symbols into one channel (one spreading code) only which is multiplexed in the multi code transmission. While, the receiving end infers a line condition (transfer function) from the pilot symbols received and, on the basis of the information thus obtained, a synchronous detection of each channel multiplexed is preferred.

Particularly, it is so arranged that a transmitting data is not transmitted by other channel in a pilot transmitting period. Or again, it is so arranged that the transmitting data is transmitted by other channel in the pilot transmitting period to the extent that reliability of the pilot symbols is not damaged largely (within a limit tolerable for practical use).

According to the present invention, at the transmitting end, interference with a pilot channel can be reduced by transmitting the pilot symbols by inserting it into one channel only. Also, at the receiving end, reliability of the pilot symbols is increased due to reduction in interference with the pilot symbols, as a result of which the synchronous detection of all multiplexed channels becomes possible, thereby improving a detection performance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a model type view showing an example of a transmission by a pilot channel.

FIG. 2 is a model type view of a channel format in a conventional multi cord transmission using a pilot channel.

FIG. 3 is a model type view of a channel format in a conventional multi cord transmission using the pilot channel.

FIG. 4 is a block diagram, showing a constitution of a CDMA Radio Multiplex Transmitting Device related to the first embodiment of the present invention.

FIG. 5 is a model type view, showing an example of a format chart in the first embodiment.

FIG. 6 is a model type view, showing an example of a format chart in a modified version of the first embodiment.

FIG. 7 is a block diagram, showing a constitution of a CDMA Radio Multiplex Receiving Device related to the second embodiment of the present invention.

FIG. 8 is a block diagram, showing a constitution of a CDMA Radio Multiplex Receiving Device related to the third embodiment of the present invention.

FIG. 9 is a mode type view, showing an example of a channel format in the forth embodiment of the present invention.

FIG. 10 is a block diagram, showing a constitution of a CDMA Radio Multiplex Receiving Device related to the fifth embodiment of the present invention.

FIG. 11 is a block diagram, showing a constitution of a CDMA Radio Multiplex Receiving Device related to the sixth embodiment of the present invention.

FIG. 12 is a block diagram, showing a constitution of a CDMA Radio Multiplex Transmitting Device related to the seventh embodiment of the present invention.

FIG. 13 is a model type view, showing an example of a channel format in the seventh embodiment.

FIG. 14 is a model type view, showing an example of a channel format in the eighth embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the embodiments of the present invention will be concretely described as follows, referring to drawings attached hereto:

(The First Embodiment)

FIG. 4 is a functional block diagram of a transmitting end in a CDMA Radio Multiplex Communication Device related to the first embodiment of the present invention. In the following description, the transmitting end of the CDMA radio multiplex communication device is referred to as a CDMA radio multiplex transmitting device and a receiving end is referred to as a CDMA radio multiplex receiving device.

The CDMA radio multiplex transmitting device as shown in the drawing is provided with a separation circuit **102** which is supplied with a transmission data **101**, a plurality of spreading circuits (**103-0**~**103-N**) connected in parallel with separated outputs from the separation circuit **102**, a plurality of switches **104** (**104-0**~**104-N**) disposed respectively between a parallel output of the separation circuit **102** and a plurality of the spreading circuits **103**, a multiplex circuit **106** which is supplied with output signals from each of the spreading circuits **103**, a radio transmitting part **107** connected with output from the multiplex circuit **106**, and an antenna **108** which is supplied with RF signal from the radio transmitting unit **107**.

A plurality of the spreading circuits **103** are prepared only in number corresponding to a plurality of spreading codes **0**~N which are assigned to users practicing the multi code transmission. Especially, a spreading circuit **103-0** assigned with a spreading code **0** is so comprised that a PL signal **105** is input via a switch **104-0**. The switch **104-0** connects selectively with a terminal which is supplied with a PL signal **105** for the spreading circuit **103** and a terminal which is supplied with the transmitting data **101**. A switchover timing for the switch **104** will be described later.

In the CDMA radio multiplex transmitting device constructed as described above, the transmitting data **101** is separated into (N+1) channels by the separation circuit **102**. A signal of each channel is spread into the spreading circuit **103** having different spreading code and multiplexed by the multiplex circuit **106**.

The pilot symbols (PL signal) **105** is inserted into a channel with a spreading code **0** by the switch **104-0** at an interval of T period. There is no transmission signal of other channel available in an insertion period(section) of the pilot symbols. Therefore, the switch **104-0** is so controlled in such manner that a transmission signal available in this section is only the pilot symbols.

FIG. **5** shows a channel format in the multi code transmission of the present embodiment. The channel format in the multi code transmission is so arranged that a PL signal transmission period **201** which is a period for transmitting a PL signal and the information data transmission period **202** which is a period for transmitting the information data such as a sound information or the like are repeated periodically. A PL signal **203** is inserted into the PL signal transmission period **201**.

When the PL signal transmission period **201** begins, the switch **104-0** of the channel having the spreading code **0** is switched over so that the PL signal **105** is input to the spreading circuit **103-0** which is assigned with the spreading code **0**. While, other switches **104-1**~**104**-N are separated from each output of the separation circuit **102**. This aspect is kept until the PL signal transmission period **201** ends. As a result, there arises a situation in the PL transmission period **201** where the PL signal **203** alone is transmitted in one channel and the transmission data **101** is not transmitted in other channel.

At the same time the PL signal transmission period **201** ends, an information data transmission period **202** begins. When the information data transmission period **202** begins, the switch **104-0** having the spreading code **0** is switched over so that a transmitting signal output from the separation channel **102** is input to the spreading circuit **103-0** which is assigned with the spreading code **0**. While, other switches **104-1**~**104**-N are switched over so that transmitting signals

of other channels which are output from the separation circuit **102** are input to corresponding spreading circuits **103-1**~**103**-N. This aspect is kept until the information data transmission period **202** ends.

Signals of (N+1) channels output from (N+1) spreading circuits **103-0**~**103**-N are multiplexed by the multiplex circuit **106** and the PL signal **203** of the spreading code **0** alone is transmitted at an interval of T period.

Signals multiplexed by the multiplex circuit **106** are modulated by the radio transmitting unit **107** and transmitted by an antenna **108** after being up-converted to transmission frequency.

As for a spreading code used for the PL signal, it is all right if it is other than a sign used for a spreading of a transmission data and it is apparent that a system giving an independent spreading code to the PL signal **301** may be allowable as an example shown in FIG. **6**.

According to the above described embodiment, the transmitting end can reduce interference with the pilot channel by transmitting the pilot symbols inserted into one channel only. Also, the receiving end can increase reliability of the pilot symbols because of reduction in the interference with the pilot symbols and, as a result, a synchronous detection of all multiplexed channels becomes possible, thereby improving a detection performance.

(The Second Embodiment)

The second embodiment according to the present invention is an example of a CDMA radio multiplex receiving device which forms a receiving end in a CDMA radio multiplex communication device of the above described first embodiment. This CDMA radio multiplex receiving device performed a synchronous detection of a data transmitted by radio communication from the same CDMA Radio Multiplex Transmitting Device as that of the first embodiment.

FIG. **7** is a functional block of the CDMA radio multiplex receiving device in the second embodiment. The CDMA radio multiplex receiving device as shown in the figure is provided with an antenna **401**, a radio receiving unit **402**, a plurality of inverse spreading circuits **403** (**403-0**~**403**-N) connected in parallel with output from the radio receiving unit **402**, a plurality of synchronous detection circuits **407** connected in parallel with output from each of the inverse spreading circuit **403**, a line condition inference circuit **406** supplied with specific output from the inverse spreading circuit **403** via a switch **404**, a plurality of binary determination circuits **408** connected in parallel with each output of the synchronizing circuit **407**, and a composition circuit **409** connected with each output of the binary value judgment circuits **408**.

In the CDMA radio multiplex receiving device constructed as described above, a signal received by the antenna **401** is down-converted by the radio receiving unit **402** and demodulated. Then it is inversely spread by the inverse spreading circuit **408**, using each spreading code.

The pilot symbols (PL signal) is extracted from a signal inversely spread by the spreading code **0** via the switch **404**. The switch **404** is connected with the line condition inference circuit **406** for a period alone that a PL signal **405** exists by synchronizing with the PL signal transmission period **201** as shown in FIG. **5** or FIG. **6**. During the other period corresponding to the information data transmission period **202**, the switch **404** is connected with the synchronous detection circuit **407**. By controlling a connection end of the switch **404** as described above, the line condition inference circuit **406** can be supplied with the PL signal **405**.

The line condition inference circuit **406** infers transfer function of a circuit on the basis of the PL signal **405** extracted from a inversely spread signal. And by using phases and the like of each symbol of the information data transmission period which are inferred in the line condition inference circuit **406**, each channel is detected by the synchronous detection circuit **407**. Furthermore, it is binary-valuated by a binary value determination circuit **408** and output as a receiving data **410** after being composed into one sequence data by the composition circuit **409**.

According to the above described embodiment, in the multi code transmission, interference with the pilot symbols is eliminated by receiving the pilot symbols which is transmitted by only one spreading code. Also, a synchronous detection of all multiplexed channels can be executed by inferring a line condition by a highly reliable pilot symbols.

(The Third Embodiment)

FIG. **8** is a functional block of a CDMA radio multiplex transmitting device in a CDMA radio multiplex communicating device in the third embodiment according to the present invention. The third embodiment is so constituted that a transmitter power of the PL signal **505** is controlled by inputting a transmission control signal **502** into a radio transmitting unit **501** of the CDMA radio multiplex transmitting device. Except that the transmitter power of the PL signal is controlled by using a transmitter power control signal, it is identical in constitution with that of the first embodiment.

In the same manner with the first embodiment, the transmitting data **501** is separated into (N+1) channels by a separation circuit **502**. Separated signals of each channel are spread by the spreading circuit **503** which has a different spreading code and multiplexed by the multiplex circuit **506**. The pilot symbols (PL signal) **505** is inserted into a channel having a spreading code **0** by the switch **504** at an interval of T period. In a pilot symbols transmission period, there exists no transmitting signal of other channel. Hence, a transmitting signal existing in this section is only the pilot signal. Multiplexed signals are modulated by the radio transmitting unit **501** and transmitted by the antenna **508** after being up-converted to transmission frequency.

At this time, in the radio transmitting unit **501**, a transmission is executed by making a transmitter power per channel of the pilot symbols transmission period stronger than other section by controlling the transmitter power periodically according to the transmitter power control signal **502**. The operation of the receiving end is identical to that of the second embodiment.

According to the above described embodiment, because interference with the pilot symbols is relatively decreased, it is possible to enhance reliability of the pilot symbols, thereby improving a synchronous detection performance.

Further, as a method for transmitting by making a transmitter power of the pilot symbols transmission period stronger than other section, such a method can be considered as possible to realize the enhancement by that the pilot symbols signal **505** before being input to the spreading circuit **503-0** is made larger compared to a transmitting data signal, in addition to a method where the transmitter power is controlled by time.

For example, in the case where the transmitting data signal is considered as a binary value signal of ± 1, if a pilot symbols signal **505** is treated as a signal of $\pm m$ and transmitted by spreading it as a signal of m times size, the pilot symbols is supposed to be transmitted by **m2** (=M) times power of the transmitter power per one channel of the transmitting data.

(The Fourth Embodiment)

The constitution of a CDMA radio multiplex transmitting device in the present embodiment is the same with that of the

first embodiment. In FIG. 4, when a transmitting data **101** is separated by the separation circuit **102**, it is separated into a control data and an information data (such as sound data, etc.) which are transmitted to the spreading circuit **103** as a different channel. However, if the transmitting data **101** is separated into two lines of the control data and the information data from the first to be input, there is no need to separate it again by the separation circuit **102**. The operation thereafter is the same with that of the first embodiment.

An example of channel format in the above described multi code transmission is shown in FIG. **9**. It is the example where signals of (N+1) channels are multiplexed and a PL signal **601** of a spreading code **0** alone is transmitted with M times power of the data transmission period at an interval of T period. In this embodiment, multiplexed channels include a D channel **602** for communication which transmits the control data and a B channel **603** for communication which transmits the information data and, by using a spreading code **0** of the D channel, the PL signal **601** is transmitted.

In the case where the control data is transmitted by spreading it into each channel, transmitting speed of the control data changes according to a number of multiplexed channels. A system where capacity of the control data does not depend on the transmitting speed of the information data is not an efficient system.

On the contrary, in the system where the control transmitting data and the information data are transmitted by a different channel as the system described above, an efficient transmission of the control data is possible without any effect from a multiple number of the information data. Hence, by adapting a system which accommodates the information data of variously different speed, an efficient transmission of the multi code can be realized.

(The Fifth Embodiment)

A functional block of a CDMA radio multiplex receiving device in a CDMA radio multiplex transmitting device according to the present embodiment is shown in FIG. **10**. The constitution of the CDMA radio multiplex transmitting device is the same with that of the first embodiment.

The present embodiment is so constituted that a RAKE composition circuit **710** is added to a device constitution as shown in the second embodiment. Therefore, except for the RAKE composition circuit **700** mentioned above, it is identical in constitution with FIG. **7**.

In the CDMA radio multiplex receiving device according to the present embodiment, a signal received by the antenna **701** is inversely spread by the inverse spreading circuit **703** by using each spreading code after it is down-converted and demodulated by the radio receiving unit **702**. The pilot symbols (PL signal) **705** is extracted from a signal inversely spread by the spreading code **0** via the switch **704** and, on the basis of the information thus obtained, transfer function of a circuit is inferred in the line condition inference circuit **706**.

At this time, the line condition inference circuit **706** not only infers phases of each symbol for a synchronous detection purpose, but it also sets or renews weighting factor of a delay line,etc. by treating the pilot symbols as a training signal necessary for the RAKE which is a path diversity. And by using phases, etc of each symbol of the inferred information data transmission period, each channel is detected by the synchronous detection circuit **707** and diversified by a RAKE composition circuit **710**.

Further, it is binary-valuated by the binary determination circuit **708** and output as a receiving data **711** after it is composed into one data sequence by the composition circuit **709**.

According to the above described embodiment, in the multi code transmission, by receiving the pilot symbols which is transmitted in one spreading code only, a line condition (transfer function) can be inferred and a synchronous detection of all multiplexed channels as well as a RAKE composition can be executed.

(The Sixth Embodiment)

A functional block of a CDMA radio multiplex receiving device in a CDMA radio multiplex transmitting device of the present embodiment is shown in FIG. **11**. The constitution of the CDMA radio multiplexed transmitting device in this embodiment is the same with that of the first embodiment.

The present embodiment is so constituted that a transmitter power control calculation section **810** is added to a device constitution as shown in the second embodiment. Therefore, except for the transmitter power control calculation section **810**, it is identical in constitution with that of FIG. **7**.

In the CDMA radio multiplex receiving device in the present embodiment, a signal received by the antenna **801** is inversely spread by the inverse spreading circuit **803**, using each spreading code after it is down-converted and demodulated by a radio receiving unit **802**. The pilot symbols (PL signal) **805** is extracted from a signal inversely spread by the spreading code **0** via the switch **804** and, on the basis of the information thus obtained, transfer function of a line is inferred in the line condition inference circuit **806**.

At this time, by obtaining a receiving power and INR (Signal to Interference—plus—Noise Ratio) in the line condition inference circuit **806**, a transmitter power is calculated by the transmitter power control calculation section **810** and output to a transmitting unit.

While, a inverse spreading signal of each channel is detected by the synchronous detection circuit **807**, using phases of each symbol inferred by the line condition inference circuit **806**. Further, it is binary-valuated by the binary determination circuit **808** and output as a received data **810** after being composed into one data sequence by the composition circuit **809**.

According to the above described embodiment, in the multi code transmission, by receiving a pilot symbols transmitted by only one spreading code, performance of the line condition (transfer function) inference is improved and a synchronous detection of all multiplex channels can be executed. At the same time, a highly effective transmitter power control can be executed.

(The Seventh Embodiment)

A functional block of a CDMA radio multiplex transmitting device in a CDMA radio multiplex transmitting device of the present embodiment is shown in FIG. **12**. The constitution of the CDMA radio multiplex receiving device in the present embodiment is the same with that of the second embodiment.

The present embodiment is so constituted that the PL signal **905**, a ramp up (RP) signal **910**, a ramp down (RD) signal **911** and the transmitting data **901** can be selectively input to the spreading circuit **903-0**. Therefore, it is provided with a switch **912**. The object of the ramping signal is to prevent a spurious emission toward outside from a transmission band which is caused by a steep rise and fall of a signal in a burst transmission.

In the CDMA radio multiplex transmitting device as constituted above, the transmitting data **901** is separated into (N+1) channels by the separation circuit **902** in the same manner with that of the third embodiment. A separated signal of each channel is spread by the spreading circuits **903-0**~**903-N** having different spreading sings and multiplexed by the multiplex circuit **906**.

The pilot symbols (PL signal) **905** is inserted into a channel (a spreading circuit **903-0**) having a spreading code **0** by a switch **912** at an interval of T period. In the case of a burst signal, there is no necessity for the T period always to be fixed. The ramp up (RU) signal **910** is inserted at the starting time of the transmission period and the ramp down (RD) signal **911** is inserted at the closing time of the transmission period. A switchover of said signals is executed by the switch **912**. In the pilot symbols and the ramping signal transmission periods, there exists no transmitting signal of other channel and therefore the channel alone of the spreading code **0** exists in the transmitting signal of these transmission periods.

A channel format example in the multi code transmission is shown in FIG. **13**. This is one embodiment of the multi code transmission in CDM/TDD. In FIG. **13**, **1001** is a PL signal, **102** is a ramp up signal, **1003** is a ramp down signal, **1004** is a guard time, **1005** is a D channel for communication, **1006** is a B channel for communication, **1007** is a transmission period and **1008** is a receiving section.

TDD is a system where the same radio frequency is time-shared for transmission/reception so as to make communication. Therefore, even in FIG. **13**, the transmission period **1007** and the receiving section **1008** are time-shared. The guard time (GD) **1004** is a section for avoiding a collision between a transmitting signal and a receiving signal. In the present embodiment, the PL signal **1001** is inserted at the starting time and the closing time of the information data. When the transmission period is longer than a PL signal insertion period T, a plurality of PL signals will be inserted into the information data.

Signals multiplexed by the multiplex circuit **906** are modulated by the radio transmitting unit **901** and transmitted from the antenna **908** after being up-converted to transmitting frequency. At this time, in the radio transmitting unit **907**, by making a transmission control periodically through the transmission power control signal **909**, it is possible to transmit by making a transmission power of the pilot symbols transmission period stronger than a transmitter power per one channel of other section. The operation of the receiving end is the same with that of the second embodiment.

In FIG. **13**, an example is shown where (N+1) channels are multiplexed and the PL signal **1001** is transmitted with M times ($1 \leqq M \leqq N+1$) of the transmission power per channel of the data transmission period. In the present embodiment, multiplexed channels include a D channel for communication **1005** which transmits a control data and a B channel for communication **1006** which transmit the information data and by using the spreading code **0** of the D channel a transmission of the PL signal **1001** is made. In the same manner, the ramp up (RU) signal **1002** at the starting time of the transmission period and the ramp down (RD) signal **1003** at the closing time of the transmission period are inserted into the D channel for communication and transmitted.

According to the above described embodiment, by transmitting not only the pilot symbols but also the ramping signal by one channel only in the multicode transmission of the burst transmission, simplification of a transmitting device can be realized. Also, in a propagation circumstance where a delay wave exceeds one symbol, the number of the spreading codes multiplexed in the ramp section is decreased and consequently the effect of interference (interrelation, etc.) given by a delay wave of the ramping signal to an adjacent symbol (which is a pilot symbols n the above described case) can be also decreased.

As described above in details, in the present invention, the transmitting end eliminates interference among the pilot symbols of each channel by transmitting the pilot symbols inserted into one channel only in multicode transmission. Also, in the synchronizing sequence system, by decreasing interference (interference among other stations), to the pilot symbols of other stations at the same time, interference performance of a line condition (transfer function) by the pilot symbols is improved. In addition, a synchronous detection performance of all multiplexed channels is improved. Further, it is also effective in that, by the improved performance of the inference of the line condition (transfer function) due to the pilot symbols, performance of the RAKE composition and a transmitter power control is enhanced.

(The Eighth Embodiment)

The constitution of a CDMA radio multiplex transmitting device in the present embodiment is the same with that of the first embodiment. In the first embodiment, there exists no transmitting signals of other channels in the pilot symbols insertion section and a transmitting signal that exists there is a pilot symbols only. On the contrary, in the present embodiment, the switch **104-0** for a channel having a spreading code **0** in FIG. **4** is switched over at an interval of T period, but switches **104-1~104-N** for channels having spreading sings **1–N** are not switched over and always in ON (connection) condition. The constitution of the CDMA radio multiplex receiving device is the same with that of the second embodiment.

FIG. **14** shows an example of a channel format in the multicode transmission of the present embodiment. A channel **0** is composed of a PL signal transmission period **1401** and an information data transmission period **1402** in T period. A PL signal **1403** is inserted into a PL signal transmission period **1401**. Signals of (N+1) channels are multiplexed and a PL signal of a spreading code **0** is transmitted at an interval of T period. At the same time, an information data is transmitted in other channel.

In the case where the data of spread (N+1) channels are transmitted from the radio transmitting unit **107** after they are separated into two orthogonalized phases (I, Q) to be multiplexed in the multiplex circuit **106**, a signal which is multiplexed and transmitted in the same phase with the channel **0** including the PL signal interfere with the PL signal. At this time, a signal of other channel which is multiplexed and transmitted in another orthogonalized phase does not interfere with the PL signal because it is orthogonalized. If not so, even in the case where an orthogonalized relation is not complete due to a delay wave existing, interference turns out only small. For this reason, it is possible to reduce interference and reliability of the pilot symbols can be enhanced. Further, since it is all right to arrange the PL signal in one code only, transmitting efficiency in the multi code transmission can be enhanced because the information data can be transmitted to the PL signal transmission period **1401** in other channels.

Also, at a receiving end, in the same manner with that of the second embodiment, a synchronous detection can be executed for all multiplexed channels by inferring a line condition from the pilot symbols of the channel **0**.

Further, in the present embodiment, it is apparent that, in the same manner with the fourth embodiment, it is possible to distinguish a transmitting data from a control data as well as an information data and transmit it from a different channel.

In a cellular system where a radio communication of a CDMA system is made between a base station device and a

mobile station device moving in cell, a highly reliable pilot symbols can be transmitted and received by providing the base station device and the mobile station device with a CDMA radio multiplex communication device as described above in the first till the eighth embodiments.

The present invention is not limited to a cellular system, but can be applied to the multicode transmission of variously different radio communication systems.

What is claimed is:

1. A transmitting device for executing radio communication by using a direct sequence CDMA system, comprising:

means for separating transmitting date into a plurality of channels;

means for periodically inserting a pilot symbol into one of many channels including said plurality of channels of said transmitting data;

means for spreading to each channel by spreading codes assigned to the transmitting data separated into said plurality of channels and the pilot symbols;

means for multiplexing the spread transmitting data and each signal of the pilot symbols; and

means for radio transmitting the multiplexed signals,

wherein data transmission is not executed by another of said plurality of channels, in a transmitting period of said pilot symbol.

2. A transmitting device according to claim 1; wherein transmitter power of the transmission period of said pilot symbols is so controlled that the transmitter power becomes stronger than transmitter power per each channel of a data transmission period of other channels.

3. A transmitting device according to claim 1; wherein

signal level of the pilot symbols before spreading thereof is set at m times (m>1) of signal level of the transmitting data before spreading thereof.

4. A transmitting device according to claim 1; wherein a control data and an information data are transmitted by a different channel when the control data and the information data are included in said transmitting data.

5. A transmitting device according to claim 1; wherein the transmitting data and pilot symbols separated into said plural channels are burst-transmitted by using TDD (Time Division Duplex) transmission or intermittent transmission system.

6. A transmitting device according to claim 5; wherein in the burst transmission by TDD transmission or intermittent transmission system, a ramping signal is transmitted only by a channel including pilot symbols.

7. A transmitting device according to claim 1; wherein the data transmission is executed by other channel in the transmitting period of said pilot symbols.

8. A transmitting device according to claim 7; when said transmitting data include control data and information data, said control data and said information data are transmitted by different channels respectively.

9. A transmitting device for executing radio communication by a direct sequence CDMA system, comprising:

a separation circuit for separating transmitting data into a plurality of channels;

a plurality of spreading circuits which are arranged corresponding to said plurality of channels including channels of the separated transmitting data;

coupling means for operatively coupling said separation circuit and said spreading circuit so that a plurality of transmitting data output from said separating circuit are input to said spreading circuit corresponding thereto,

pilot insertion means for periodically inputting a pilot symbol into one of plural spreading circuits disposed corresponding to said plural channels;

a multiplex circuit for multiplexing each of spread signals output from each of said spreading circuits; and

a radio transmitting circuit for radio transmitting multiplexed signals output from said multiplex circuit, wherein said radio transmission circuit only transmits said pilot symbol in a transmitting period of said pilot symbol.

10. A transmitting device according to claim 9; wherein said coupling means simultaneously releases a connection of each of said separation circuits and each of said spreading circuits at the starting time of a pilot transmitting period periodically arriving and simultaneously releases the connection of said separation circuits and said spreading circuits at the closing time of the present pilot transmitting period

and that said pilot insertion means starts inputting said pilot symbols into one of said spreading circuits at the starting time of said pilot transmitting period and stops inputting said pilot symbols at the closing time of the present pilot transmitting period.

11. A transmitting device according to claim 9; wherein said coupling means always connections each of spreading circuits and said separation circuits except for said spreading circuits where said pilot symbols are input and releases the connection of said separation circuits and said spreading circuits where pilot symbols are input at the starting time of the present pilot symbols transmitting period,

and that said pilot insertion means starts inputting said pilot symbols into said pilot spreading circuits at the starting time of said pilot transmitting period and stops inputting said pilot symbols at the closing time of the present pilot symbols transmitting period.

12. A transmitting device according to claim 9; wherein said coupling means always connections each of said separation circuits and said spreading circuits except for said spreading circuit where said pilot symbols are input,

and that said pilot insertion means starts inputting said pilot signals into said spreading circuits at the starting time of said pilot transmitting period and stops inputting said pilot symbols at the closing time of said pilot transmitting period.

13. A receiving device for executing radio communication by a direct sequence CDMA system, comprising:

means for receiving radio signals;

means for assigning the received signals into a plurality of channels corresponding to a number of channels available at a transmitting end;

means for inversely spreading, in parallel, signals assigned to the plurality of channels both including spreading codes used for spreading of transmitting data at the transmitting end and by plural spreading codes used for spreading of pilot symbols, wherein the transmitting end does not transmit data in another channel in a transmitting period of said pilot symbols;

means for extracting pilot symbols from inversely spread signals by spreading codes used for spreading of said pilot symbols;

means for inferring transfer function of lines from the extracted pilot symbols;

means for executing in parallel a synchronous detection of plural signals inversely spread by a plurality of spreading codes used for inverse spreading of said transmitting data; and

means for composing a plurality of signals which are synchronizing detected.

14. A receiving device according to claim 13;

comprising a means for executing a RAKE composition on the basis of a line condition inferred from said pilot symbols.

15. A receiving device according to claim 13, comprising;

means for detecting receiving power or SINR (Signal to Interference plus Noise Ratio) from said pilot symbols and;

means for generating signals for controlling transmitter power corresponding to line condition or communication quality from detected receiving power or SINR.

16. A receiving device for executing radio communication by using a direct sequence CDMA system, comprising;

a radio receiving circuit for assigning signals received by radio communication into a plurality of channels;

a plurality of spreading circuits for inversely spreading signals supplied in parallel from said radio receiving circuit by a plurality of spreading codes including spreading codes used for spreading of transmitting data in the transmitting end and spreading codes used for spreading of a pilot symbols;

pilot extracting means for extracting said pilot symbols according to an insertion period of tie pilot symbols periodically inserted by the transmitting end from output signals of spreading circuit assigned with spreading codes used for spreading of said pilot symbols, wherein the transmitting end does not transmit data in another of said plurality of channels in a transmitting period of said pilot symbols;

a line condition inference circuit for inferring transfer function of line from the extracted pilot symbols;

a plurality of synchronous detection circuits for synchronously detecting output signals of corresponding spreading circuits on the basis of said inferred transfer function of lines disposed respectively corresponding to said plural spreading circuits; and

a composition circuit for composing output signals of said synchronous detection circuits.

17. A radio communication device having transmitting and receiving devices for transmitting and receiving data by a direct sequence CDMA system; comprising;

means for separating transmitting data into a plurality of channels;

means for periodically inserting pilot symbols into one of plural channels including channels of said transmitting data;

means for spreading said transmitting data separated into said plural channels and pilot symbols by spreading codes respectively assigned to each channel;

means for multiplexing each signal of the spread transmitting data and pilot symbols;

means for radio transmitting said multiplexed signals, said means for radio transmitting not transmitting data in another of said plural channels in a transmitting period of said pilot symbols;

wherein said receiving device comprises

means for receiving radio signals;

means for assigning the received signals into plural channels corresponding to a number of channels at the transmitting end;

means for inversely spreading in parallel signals assigned into plural channels by plural spreading codes including spreading codes used for spreading of transmitting data by the transmitting end and spreading codes used for spreading of pilot symbols;

means for extracting pilot symbols from signals inversely spread by spreading codes used for spreading of said pilot symbols;

means for inferring transfer functions of lines from the extracted pilot symbols;

means for synchronously detecting in parallel a plurality of signals inversely spread by a plurality of spreading codes used for inverse spreading of said transmitting data; and

means for composing a plurality of signals synchronously detected.

18. A base station device for radio communicating with a mobile station device by a direct sequence CDMA system; comprising a radio communication device as described in claim 17.

19. A mobile station device for communication by radio with a base station device by a direct sequence CDMA system;

comprising a radio communication device as described in claim 17.

20. A method for performing radio communication by direct sequence CDMA system, comprising:

separating transmitting data into a plurality of channels;

periodically inserting a pilot symbols into one of said plurality of channels including channels for the transmitting data, wherein data is not transmitted by another of said plurality of channels in a transmitting period of the pilot symbols;

spreading the transmitting data separated into said plurality of channels and the pilot symbols by spreading codes assigned to respective channels;

multiplexing respective signals of the diverged transmitting data and the pilot symbols; and

radio transmitting said multiplexed signals.

21. A method for performing radio communication by direct sequence CDMA system, comprising:

separating transmitting data into a plurality of channels;

periodically inserting a pilot symbols into one of said plurality of channels including channels for the transmitting data, wherein data is not transmitted by another of said plurality of channels in a transmitting period of the pilot symbols;

spreading the transmitting data separated into said plurality of channels and the pilot symbols by spreading codes assigned to respective channels;

multiplexing respective signals of the diverged transmitting data and the pilot symbols;

radio transmitting said multiplexed signals; and

controlling the transmitter power of the transmitting period of said pilot symbols so as to become stronger than the transmitter power per one channel of the data transmitting period of the other channels.

22. A method for performing radio communication by direct sequence CDMA system, comprising:

separating transmitting data into a plurality of channels;

periodically inserting a pilot symbols into one of said plurality of channels including channels for the transmitting data, wherein data is not transmitted by another of said plurality of channels in a transmitting period of the pilot symbols;

spreading the transmitting data separated into said plurality of channels and the pilot symbols by spreading codes assigned to respective channels;

multiplexing respective signals of the diverged transmitting data and the pilot symbols;

radio transmitting said multiplexed signals; and

setting the signal level of the pilot symbols before spreading to amount of m (m>1) times of the signal level of the transmitting data before spreading.

23. A method for performing radio communication by using a direct sequence CDMA system, comprising the steps of:

receiving a radio signal;

assigning the received signal into a plurality of channels corresponding to a number of channels at transmitting end;

spreading inversely the signal assigned into the plurality of channels by a plurality of spreading codes including the spreading code used for spreading of transmitting data at the transmission end and the spreading code used for spreading of the pilot symbols, wherein data is not transmitted by another of said plurality of channels in a transmitting period of said pilot symbols;

extracting the pilot symbols from the signals inversely diverged by the spreading code used for spreading of said pilot symbols;

inferring transfer function of line from the extracted pilot symbols;

detecting synchronously in parallel the plurality of signals inversely spread by the spreading code used for inverse spreading of said transmitting data, corresponding to the inferred transfer function of line; and

composing the plurality of signals detected synchronously.

24. A method according to claim 23, further comprising the step of:

performing RAKE composition based on the line condition inferred from said pilot symbols.

25. A method according to claim 23, further comprising the steps of:

detecting the reception electric power or SINR (Signal to Interference-plus-Noise Ratio) from said pilot symbols; and

generating a signal to control the transmitter power corresponding to the line condition or communication quality from the detected reception electric power or SINR.

26. A transmitting device for executing radio communication by using a direct sequence CDMA system, comprising:

means for separating transmitting data into a plurality of channels;

means for periodically inserting a pilot symbol into one of many channels including said plurality of channels of said transmitting data;

means for spreading to each channel by spreading codes assigned to the transmitting data separated into said plurality of channels and the pilot symbols;

means for multiplexing the spread transmitting data and each signal of the pilot symbols; and

means for radio transmitting the multiplexed signals,

wherein said pilot symbols are periodically inserted into a channel different from a channel of said transmitting data.

27. A transmitting device according to claim 26, wherein data transmission is not executed by an other channel in a transmitting period of said pilot symbols.

28. A transmitting device according to claim 27, wherein transmitter power of the transmission period of said pilot symbols is so controlled that the transmitter power becomes stronger than transmitter power per each channel of a data transmission period of other channels.

29. A transmitting device according to claim 27, wherein a signal level of the pilot symbols before spreading thereof is set at m times (m>1) of signal level of the transmitting data before spreading thereof.

30. A transmitting device according to claim 26, wherein a control data and an information data are transmitted by a different channel when the control data and the information data are included in said transmitting data.

31. A transmitting device according to claim 26, wherein the transmitting data and pilot symbols separated into said plurality of channels are burst-transmitted by using TDD (Time Division Duplex) transmission or intermittent transmission system, and in the burst-transmission by TDD transmission or intermittent transmission system, a ramping signal is transmitted only by a channel including pilot symbols.

32. A method for performing radio communication by direct sequence CDMA system comprising:

separating transmitting data into a plurality of channels;

periodically inserting a pilot symbol into one of said plurality of channels including channels for the transmitting data;

spreading the transmitting data separated into said plurality of channels and the pilot symbols by spreading codes assigned to respective channels;

multiplexing respective signals of the diverged transmitting data and the pilot symbols;

radio transmitting said multiplexed signals; and

controlling the transmitter power of the transmitting period of said pilot symbols so as to become stronger than the transmitter power per one channel of the data transmitting period of the other channels.

33. A method according to claim 32, further comprising:

setting the signal level of the pilot symbols before spreading to an amount of m (m>1) times of the signal level of the transmitting data before spreading.

34. The transmitting device according to claim 1, wherein only said pilot symbol is transmitted in a transmitting period of said pilot symbol.

35. The receiving device according to claim 13, wherein the transmitting end only transmits said pilot symbol in a transmitting period of said pilot symbol.

36. The receiving device according to claim 16, wherein the transmitting end only transmits said pilot symbol in a transmitting period of said pilot symbol.

37. The radio communication device according to claim 17, wherein, said means for radio transmitting only transmits said pilot symbol in a transmitting period of said pilot symbol.

38. The method according to claim 20, wherein only said pilot symbols are transmitted in a transmitting period of the pilot symbols.

39. The method according to claim 23, wherein only said pilot symbols are transmitted in a transmitting period of the pilot symbols.

40. A transmitting device for executing radio communication by using a direct sequence CDMA system, comprising:

means for separating transmitting data into a plurality of codes comprising a plurality of channels;

means for periodically inserting a pilot symbol into one of many codes including said plurality of codes of said transmitting data;

means for spreading to each channel by spreading codes assigned to the transmitting data separated into said plurality of channels, and the pilot symbols;

means for multiplexing the spread transmitting data and each signal of the pilot symbols; and

means for radio transmitting the multiplexed signals,

wherein data is not transmitted in another code in a transmitting period of said pilot symbols.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,175,558 B1
DATED : January 16, 2001
INVENTOR(S) : K. Miya

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 11,
Line 12, "date" should be "data".

Column 13,
Line 25, "tie" should be -- the --.

Signed and Sealed this

Twelfth Day of February, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer